Realization of full magnetoelectric control at room temperature

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Abstract

The control of magnetization by an electric field at room temperature remains as one of great challenges in materials science. Multiferroics, in which magnetism and ferroelectricity coexist and couple to each other, could be the most plausible candidate to realize this long-sought capability. While recent intensive research on the multiferroics has made significant progress in sensitive, magnetic control of electric polarization, the electrical control of magnetization, the converse effect, has been observed only in a limited range far below room temperature. Here we demonstrate at room temperature the control of both electric polarization by a magnetic field and magnetization by an electric field in a multiferroic hexaferrite. The electric polarization rapidly increases in a magnetic field as low as 5 mT and the magnetoelectric susceptibility reaches up to 3200 ps/m, the highest value in single phase materials. The magnetization is also modulated up to 0.34 mB per formula unit in an electric field of 1.14 MV/m. Furthermore, this compound allows nonvolatile, magnetoelectric reading- and writing-operations entirely at room temperature. Four different magnetic/electric field writing conditions generate repeatable, distinct *M* versus *E* curves without dissipation, offering an unprecedented opportunity for a multi-bit memory or a spintronic device applications.

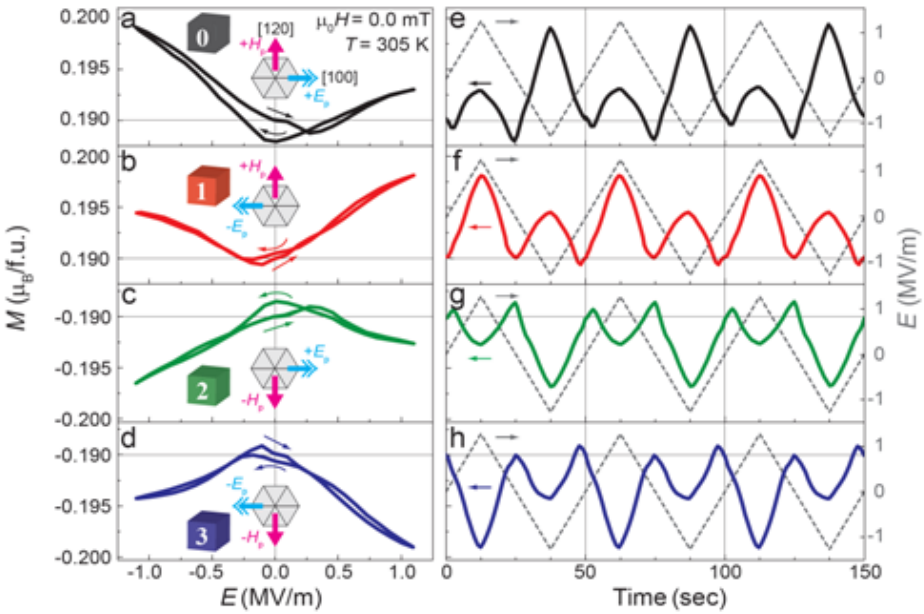

Figure 1. Control of *M* by E at zero H-bias at different magnetoelectric annealing conditions